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ABSTRACT

An outline of fundamental definitions, relationships, and human responsibilities related to environment provides a basis from which a variety of materials, programs, and activities can be developed. The outline can be used in elementary, secondary, higher education, or adult education programs. The framework is based on principles of the science of ecology and integrates relevant constructs from the social, behavioral, physical, biological, environmental design, and legal disciplines. Section one states the natural principles about the operation of all earth's ecosystems, man-created and natural. This includes discussion of the supply and use of energy by component parts within the ecosphere. Section two discusses fundamentals about the functioning of the human species in the earth's ecosystems--how humans affect and are affected by ecosystems and how humans are accountable for their effects on ecosystems. The third section describes processes, methods, and tools for using the fundamentals to harmonize human activities in the earth's ecosystems. Specific U.S. laws and international environmental policies are cited. Section four provides examples of broad questions that individuals and multinational groups must address in order to preserve the quality of human life on earth. These issues include food production capacity and land suitability planning. (Author/AV)

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FUNDAMENTALS of ENVIRONMENTAL EDUCATION

Report of the Subcommittee on Environmental Education, Federal Interagency Committee on Education

SP009 770

NOVEMBER 1976

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
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2

The Federal Interagency Committee on Education (FICE) was created by Executive Order in 1964 and currently operates under an updated mandate, Executive Order 11761, issued in January 1974. Chaired by the Assistant Secretary for Edcuation, FICE's functions are to improve coordination of the educational activities of Federal agencies; to identify the Nation's educational needs and goals; and to advise and make recommendations on educational policy to the Secretary of Health, Education, and Welfare and, through him, to heads of other agencies and the President.

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FUNDAMENTALS OF ENVIRONMENTAL EDUCATION

A paper developed by the Subcommittee on Environmental Education

Beatrice E. Willard, Chairperson
Member, President's Council on Environmental Quality

November 1976

U. S. Department of Health, Education, and Welfare
Office of the
Assistant Secretary for Education

Washington, D. C.

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Foreword

"....that it is the continuing policy of the Federal Government....to create and maintain conditions under which men and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans...."

--from the National Environmental Policy Act of 1969 (P. L. 91-190, Section 101a)

This "Environmental Fundamentals" paper was developed by the FICE Subcommittee on Environmental Education in the spirit of the above mandate. It attempts to set forth fundamentals about environment that informed citizens need to understand in order to deal with the wide variety of environmental issues confronting them today.

On the basis of these concepts the Subcommittee proposes to inventory environmental activities now going on in Federal agencies. It is hoped that the inventory when analyzed in view of this fundamentals paper will provide a basis for identifying gaps in Federal agency activities, recommendations for remedying these gaps or improving coordination of programs. The Subcommittee also is exploring other avenues of making this paper useful, including using it as the basis for discussions at the U. N. Intergovernmental Conference on Environmental Education to be held in Russia in 1977.

This paper represents the work of the Subcommittee chaired by Dr. Beatrice E. Willard, Member, President's Council on Environmental Quality. It was reviewed and criticized by a multi-disciplined panel of non-Federal experts, as well as by Federal agencies staffs, and received the endorsement of the Federal Interagency Committee on Education on July 14, 1976.

Bernard Michael

Bernard Michael
Executive Director
Federal Interagency Committee
on Education

FUNDAMENTALS OF ENVIRONMENT:
A Framework for Environmental Education

Introduction

This framework of fundamentals about our environment was created by the Environmental Education Subcommittee of the Federal Interagency Committee on Education. It is intended to help individuals and groups understand the environmental[1] issues of today and tomorrow; develop realistic environmental, social, and economic goals; set priorities for reaching those goals; and make rational decisions about environmental issues.

The Subcommittee used the principles of the science of ecology[2] as a means for integrating and organizing relevant constructs from the social, behavioral, physical, biological, environmental design, and legal disciplines into a coherent framework for fundamentals about environment. Some nontraditional conceptual "bridges" have been used among these disciplines to improve communication and integration of ideas, techniques, and information.

The biosphere is subdivided into functional units known as ecosystems[3] which are studied with a holistic viewpoint. Human beings plus their activities are viewed as natural components of ecosystems--those in which they occur, those they create, and those on which they have some effect.

A functional grasp of the fundamentals concerning the operation of ecosystems assists citizens in obtaining a clear, systematic, scientific, dispassionate picture of the world around them. This framework is designed to help achieve that capability for understanding, coordination, and action necessary for a balanced approach to improving environmental

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1/ "Environment" is the sum total of the physical, chemical, biological, social, economic, political, aesthetic, structural surroundings for organisms.

2/ "Ecology" is the scientific study of human and nonhuman organisms, their relationship to their physical environment (air, water, land, sun, etc.) and to each other. The discipline presupposes a "holistic" view of the universe and its intricate interrelationships.

3/ "Ecosystems" are homogeneous, recognizable units of the biosphere that include human beings, their activities and products, together with physical factors, other organisms, and processes operating among these components.

quality as mandated by the National Environmental Policy Act of 1969 (NEPA). This framework can be used to provide criteria for surveying, coordinating, initiating, and redesigning federal programs and activities. It can provide criteria for designing, implementing, and evaluating programs, activities, and materials in the broad field of environmental education at all levels. It can provide utility in defining divisions of labor in the public and private sectors. It can facilitate communications and decisions from the individual to the multinational levels. This document is not designed as a syllabus, but as a basis from which can emanate a wide variety of materials, activities, and programs.

The framework is divided into four sections: the first states the natural principles about the operation of all Earth's ecosystems--man-created and natural; the second contains fundamentals about the functioning of the human species (as an unusual one) in Earth's ecosystems; the third describes processes, methods, and tools for using the fundamentals to harmonize human activities in Earth's ecosystems; and the fourth gives examples of broad questions that individuals and multinational groups alike must address and solve if the quality of human life and civilization is to be maintained on Earth.

I sincerely compliment and thank the Subcommittee and its task forces for their hard work, perserverance, and dedication to achieving this product and to initiating a variety of followup activities. They would appreciate comments from users and people interested in environmental education everywhere. Comments should be mailed to the Subcommittee on Environmental Education, Office of the Assistant Secretary of Education, Washington, D. C. 20201.

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16 November 1976
Washington, D. C.

TABLE OF CONTENTS

	Page
FOREWORD	iv
INTRODUCTION	vi
I. Fundamentals about Earth's environment	1
A. Earth's environment	1
B. The ecosphere	1
C. Energy and materials	4
D. The ecosystem	4
II. Fundamentals concerning humans as ecosystem components	6
A. Humans use ecosystems	6
B. Humans affect ecosystems	8
C. Ecosystems affect humans	9
D. Complex interactions	10
E. Human accountability	12
III. Methods for harmonizing human activities with ecosystem processes to achieve environmental quality	13
A. Different kinds of methods	13
B. Institutions, processes and attitudes for implementation	14
C. Process for harmonizing human activities with ecosystem processes	14
D. Formal policy and law	15
IV. Using fundamentals of the environment and understanding the methods	19
A. Questions	19
B. Issues	19
CONCLUSION	19

SECTION I. FUNDAMENTALS ABOUT EARTH'S ENVIRONMENT

A. Earth's environment is a whole.

B. The ecosphere is a dynamic, constantly changing macro-system--a mosaic of ecosystems.

C. The energy and materials necessary for all life are components of each ecosystem.

D. Each ecosystem includes a number of species populations.

* * *

A. Earth's environment is a whole.

1. The natural conditions on Earth that support the development and maintenance of ecosystems are a function of Earth's place in the solar system and the structure of Earth.

a. Solar energy is the primary source of energy for all the physical, chemical and biochemical cycles and other processes occurring on Earth. Secondary sources of energy include nuclear processes, tidal, gravitational, and geothermal sources.

b. Earth absorbs energy from the sun and radiates energy into space. It is in a state of overall energy balance.

c. The influx and distribution of solar energy gives rise to the climates that prevail on Earth. It powers the movement of global air masses, the hydrologic cycle, ocean currents. It provides conditions essential to the life on Earth.

2. Earth's environment constitutes a complex interrelated, interactive life support system called the "ecosphere".

B. The ecosphere is a dynamic, constantly changing macro-system--a mosaic of ecosystems.

1. The ecosphere is composed of interacting systems called ecosystems.

a. An ecosystem is a recognizable, homogeneous unit of the ecosphere and exists at a particular point in space and time. Each ecosystem consists of three groups of components: (1) physical factors (sun's energy, climate, rocks, water, etc.); (2) living organisms, including humans; and (3) interactions among and/or between living and nonliving components (competition, erosion, decomposition, etc.).

b. Each ecosystem has "system" characteristics that derive from the interactions of the system's components and differ from the characteristics of individual components. Therefore, the system functions in ways that cannot be understood by studying only its parts.

c. Ecosystem processes are limited by such physiochemical attributes as the availability of energy, materials, space, time, and the inherited characteristics of organisms.

d. The characteristics of each individual organism depend upon interactions of its genetic composition with its total environment.

e. These characteristics fit each population to function in particular roles known as "niches." Populations are interdependent with one another and with their physical environment, impacting upon and being impacted by each other and their environment.

f. Both ecosystems and species vary in their ecological amplitude, i.e., their parameters and capacities to interact with other components of the ecosystem and with other ecosystems.

2. The ecosphere and all its ecosystems undergo continuous change.

a. Throughout its history, Earth has undergone and continues to undergo extensive changes in environmental factors, such as climate, topography, geologic processes and distribution of oceans and continents.

b. Organisms have changed greatly through small consecutive modifications of their genetic composition, thus adapting to their environment. Such changes continue to occur through time and space. Extinction of species has resulted from failure to adapt to environmental change.

c. Ecosystems arise as organisms invade formerly lifeless water, or bare mineral substrates (rocks, sand), or as pre-existing ecosystems are modified. New combinations of organisms and environments produce new ecosystems. As ecosystems operate through time, their living and non-living components contribute to, interact with, and change the character of the system. Natural and human processes (fires, landslides, earthquakes, urbanization, etc.), alter ecosystems in varying degrees. Ecosystems have various degrees of resiliency to alteration, giving them varying capacities and rates of recovery from alteration. If a given ecosystem is perturbed enough, by removal of old or addition of new components and change of processes, it can be reduced to near or actual extinction. However, some type of ecosystem subsequently will develop unless the area is rendered toxic to all life for extended periods.

d. As an ecosystem persists and matures through long periods of time there is a tendency toward an increase in the diversity of organisms. In mature ecosystems, a steady-state character persists, even though individual organisms and species arrive, die, or depart, and even though particular kinds of organisms may not always be present. In general, complex mature ecosystems are more resilient to physical, biological, economic, and social variations than developing systems and generally are more stable.

e. Niches become more specialized as ecosystems mature. Changes in ecosystems interact with changes in organisms, resulting in greater specialization of niches. Some species have expanded their niches by learned behavior. These changes enable more types of organisms to live in the ecosystem, thus further changing its character.

f. Some characteristics of an ecosystem are influenced strongly by its origin and history.

C. The energy and materials necessary for all life are components of each ecosystem.

1. Energy used in all ecosystems comes originally and primarily from the sun; materials come from components of the ecosphere.

2. Green plants, through photosynthesis, use the sun's energy to convert water, carbon dioxide, and small amounts of minerals into high-energy organic compounds that power all life processes. This energy is released by the process of respiration in organisms. Both of these processes (photosynthesis and respiration) are limited to fairly narrow ranges of temperature, moisture, and chemical conditions, and by the genetic composition of organisms.

3. Materials are cycled and recycled via foodwebs through plants to herbivores to fewer carnivores, etc. Ultimately they are reduced by many decay organisms to inorganic forms, completing the cycle, as materials are reused. Examples are the nitrogen and carbon cycles.

4. Some energy moves through the physical and chemical components of ecosystems; the rest flows through foodwebs. No energy conversion is 100 percent efficient, so energy is constantly dissipated from the system. This dissipation of energy results in a deficit. A constant infusion of additional energy is required for organisms and ecosystems to live and to grow. The sun provides this energy. Some energy is stored in organic materials that can be used in the future.

5. Most natural ecosystems are adapted to operate on the energy and materials directly available to them. These resources are renewable by recycling; in natural ecosystems, the rates of consumption and renewal are balanced. While primitive human social groups are similiarly adapted, modern man-made systems require heavy subsidization of energy and materials.

D. Each ecosystem includes a number of species populations, the size and stability of which vary, depending on biotic and abiotic changes in the system.

1. When a population is introduced into an ecosystem to which it is adapted, the excess of births over deaths results in a typically S-shaped pattern of growth. Growth levels off as birth and death rates equalize; decline occurs as death rate exceeds birth rate.

2. Birth rate and death rate are influenced by factors intrinsic and extrinsic to the population ("limiting factors"). Intrinsic factors are genetic (reproductive capacity, innate behavior, food requirements, resilience, etc.). Extrinsic factors are environmental. They include chemical factors (nutrients, toxins, etc.) and physical factors (temperature, humidity, etc.), as well as factors related to interactions with its own and other populations (competition, predation, parasitism, etc.). Density of a population affects all of these extrinsic relationships.

   a. For modern humans, birth rate is affected primarily by socio-cultural means (e.g., delay in marriage, contraception, abortion, etc.); death rate during infancy, childhood, and even adulthood is affected by technology (e.g., medical science, sanitation, dietary improvement, etc.). While both have changed in recent times, the net result has been a substantial increase in size and growth rate of the world's human population.

3. The size of a population in an ecosystem will vary from time to time with changes in physio-chemical factors and with biological interactions, thus defining the "carrying capacity" of the ecosystem for that population under a given set of conditions. To a degree, an ecosystem's carrying capacity can be increased by technology, but only within finite limits.

4. Spatial arrangements of individuals in populations are as important in ecosystem functioning as total numbers of individuals in the population.

5. Ecological amplitude, environmental barriers to dispersal, and history control distribution of populations.

SECTION II. FUNDAMENTALS CONCERNING HUMANS AS ECOSYSTEM COMPONENTS

A. Humans make use of ecosystems to satisfy basic needs and desires.

B. Humans affect ecosystems.

C. Ecosystems affect humans.

D. Complex interactions among humans and other ecosystem components occur continuously.

E. Humans are accountable for their effects on ecosystems.

* * *

Organisms influence the characteristics of ecosystems and are, in turn, strongly influenced by the characteristics of the ecosystems in which they live. Humans now are the most influential of the Earth's organisms and influence all of Earth's ecosystems.

A. Humans use ecosystems to satisfy basic needs and desires:

1. The basic biological needs that must be met for humans to live and to grow and for the species to survive:

   a. Habitable climate--temperature range, moisture, etc.

   b. Energy and materials--food, air, water, organic chemicals, etc.

   c. Rest and exercise.

   d. Other humans for reproduction.

   e. Protection against environmental stresses--sun, wind, rain, disease, etc.

2. Among humans, essential psychological and social needs and desires requiring fulfillment include security, love, esteem, self-fulfillment, social interaction, health, comfort, material goods, religious experiences. Humans cannot grow and completely develop mentally unless these needs are met.

3. Human cultures each have their own perceived needs and desires that make different demands and impacts on ecosystems. In time of stress, many of these needs and desires can be adjusted.

   a. Universal human desires for more and more material goods are expressed differently in different cultures. As the satisfaction of these desires increases, human impact on ecosystems increases.

   b. Value systems play a highly significant role in determining the kind and extent of a society's impact on ecosystems.

   c. Increasing the consumption of energy and materials often leads to deleterious impacts on ecosystems.

      (1) Increased CO_2 and heat in atmosphere, e.g., heat islands over cities.

      (2) Albedo[1/] changes

      (3) Introduction of new synthetic substances that produce an effect that is an order of magnitude different (and often adverse) on living systems, e.g., chemicals that are toxic mutagenic, carcinogenic, either chronic or acute.

   d. Concentration of humans, especially in built environments, intensifies the deleterious effects of humans on ecosystems.

   e. Among culturally-specific perceived needs are:

      (1) Preservation of land, ecosystems, and species, together with conservation of materials and energy.

      (2) Satisfaction of desires for status and for exotic materials and experiences.

      (3) Economies of scale concentrating human activities that result in major changes in ecosystems.

      (4) Planned obsolescence of manufactured goods.

      (5) Dietary customs, family size, work attitudes.

1/ Reflective power: that fraction of incident light reflected by a surface or body.

B. Humans affect ecosystems, as an all-pervasive species in the ecosphere that has a special type of ecological dominance, exerting major kinds of influences on ecosystems.

1. Human domination results from:

a. Intellectual capacities that permit the development of:

(1) Technology that gives unique control over energy flows, food and goods production, disease, and other factors that would otherwise limit human populations.

(2) Unique institutional and technological control over other populations in ecosystems; e.g., domestication of some species--pigs, dogs, cows; suppression of "undesirable species"--rats, mosquitos, dandelions, etc.; and encouragement of "desirable species"--Kentucky bluegrass, shade trees, pheasants, deer, etc.

b. Biological and cultural adaptation to a wide range of environmental conditions, which greatly increases effects of humans on ecosystems ranging from improvement to destruction.

(1) The built environment on a metropolitan scale constitutes a major change in kinds of human settlements.

c. Sheer population size.

d. Great specialization and diversity in the division of labor.

2. Human tendencies to form and function in social and corporate groups and institutions promote development of human habitats that currently create unique concentrated demands on ecosystems and further increase human effects on ecosystems.

a. These effects are augmented by concentration of humans into small areas, such as metropolises.

b. Human settlements on a metropolitan scale have effects on ecosystems that rival those of mountains, glaciers, droughts, and floods.

3. Burgeoning human populations and technological capabilities are of relatively recent origin. This increasingly rapid growth and development has brought to ecosystems increasingly rapid changes, some of which are potentially irreversible.

4. Human aesthetic, ethical, moral, and spiritual values reinforce and/or conflict with harmonious relationships within ecosystems.

C. Ecosystems affect humans, as the arenas in which all human perception and activity take place.

1. Humans and all their products function in an ecosystem framework.

a. The built environment radically transforms human society and culture--as space, as function, as sensory stimulus, as motivation, as support, as hazard.

b. Past ecosystem processes and events have produced major biological and cultural differences in human populations.

2. Changes in the ecosphere due to increasing human numbers and technology have short- and long-term effects, e.g.,

a. Short-term effects on:

(1) Birth and death rates

(2) Biological fitness of human populations as measured by growth rates, disease patterns, nutritional levels, aging, etc.

(3) Use of non-renewable materials and stored energy sources.

(4) Functional capacities of individuals and populations--mental productivity, attitude, etc.

(5) Renewable resources.

b. Long-term effects on:

(1) Genes and chromosomes and their evolutionary consequences.

(2) Selection pressures--elimination of some and/or introduction of others.

(3) Ecosystem changes resulting from evolution of their component populations.

(4) Health and life cycles.

(5) Global climate.

(6) Reserves of non-renewable and renewable resources.

(7) Culture.

3. Although several species exhibit non-genetic information transfer, the built environment and the psychological milieu have a powerful effect on humans because information transfer by verbal and learned behavior is such a large part of the contemporary human environment. They operate on humans in a parallel and synergistic manner in much the same way as do physical and chemical components of ecosystems.

D. Complex interactions among humans and other ecosystem components occur continuously.

1. Humans' perceptions of their needs, their impacts on ecosystems, and ecosystem impacts on them reflect the cultural and individual values, goals, skills, insights, and capabilities of the individuals, groups, institutions, and nations involved.

2. Relationships among components of ecosystems are reciprocal, ranging from mutually beneficial to unidirectionally destructive.

3. A governing relationship among and within components of ecosystems is a feedback mechanism (physical, chemical, social, behavioral), ranging from highly sophisticated to rudimentary.

4. Human activities often have synergistic effects on ecosystems and vice versa.

5. Human activities present both solutions and problems for ecosystem maintenance and management.

   a. Potentially positive activities of humans within ecosystems, some evidences are:

      (1) Domestication and husbandry of plants and animals.

      (2) Reduction of disease and mortality.

      (3) Constructed and controlled space for living, working, manufacture, storage, recreation, transportation, etc.

      (4) Preservation of genetic stocks of non-domesticated organisms and preservation of specific ecosystems.

      (5) Perception and appreciation of ecosystems and their components.

      (6) Development of human law and property rights.

      (7) Reduced human populations under certain social-cultural conditions.

      (8) Elaboration of functional roles (i.e., niches) for humans, which increases diversity of ecosystems.

   b. Potentially destructive activities of humans within ecosystems, some evidences are:

      (1) Discrete large scale events that warn of imbalances between human activities and ecosystem functioning (e.g., changes in atmosphere, marine oil slicks, dustbowls, floods, etc.).

      (2) Decreasing numbers of individuals, declining continuity and area of ecosystem-type, and reduced average species diversity for given ecosystem type (e.g., decline of predatory birds and mammals, of tall grass prairies, etc.).

(3) Increases in environmentally-induced human health problems (e.g., pollution-induced disease, noise-induced deafness, etc.).

(4) Destruction/modification of habitats, creation and concentration of pollutants, and other inadvertent or deliberate acts.

(5) High rates of energy dissipation and production of pollutants in heavily urban areas.

(6) Depletion of relatively concentrated sources of raw materials.

E. Human ability to comprehend both the basic concepts about ecosystem processes, and the consequences of human actions in relation to ecosystem processes, short- and long-term, must be coupled with their ability to control their actions, in order to produce an ethic of accountability for human impacts on ecosystems. The preservation of civilizations as we know them depends on the exercise of an ethic of accountability for human impacts on ecosystems, balanced with the realization that humans require modification of the natural environment (housing, vehicles, agriculture, extensions of communication--e.g., books, radios, TV, etc.) which, even if primitive and crude, allows humans in small groups to extend culture beyond the mere survival level.

SECTION III. METHODS FOR HARMONIZING HUMAN ACTIVITIES WITH ECOSYSTEM PROCESSES TO ACHIEVE ENVIRONMENTAL QUALITY

A. Different kinds of methods.

B. Institutions, processes, and attitudes for implementation.

C. One basic process for harmonizing human activities with ecosystem processes.

D. Formal policy and law.

* * *

Using the fundamentals of environment outlined in Sections I and II, this section focuses on ways to implement positive actions for harmonizing human activities with ecosystem processes. This section is especially applicable in the United States, but has relevance elsewhere in the world.

A. The methods by which human activities, local through global, are harmonized with ecological processes, are complex and outcomes are not always predictable. Effects of ecosystem changes on human biology and culture are inevitable, ever present, and of limited susceptibility to management. Detailed knowledge needed to make environmental predictions often is incomplete or unavailable. There are not uniformly dependable social-political processes for responsible decision-making. The ways that societies pursue harmonization include:

1. Education of the public, formal and nonformal.

2. Appreciation and practice of various art forms in sensitizing humans to different types and facets of environmental quality.

3. Encouragement of corrective actions by individuals, businesses, government agencies, etc.

4. Voluntary adoption and implementation of policies and standards.

5. Establishment of formal policies, guidelines, and standards.

6. Use of economic and social incentives.

7. Enforcement of policies, guidelines, and standards.

B. Institutions, processes, and attitudes for implementing investigative, preventive, remedial, and creative actions that will harmonize human activities with ecosystem processes are:

1. Education and communication

2. Religious, aesthetic, ethical, and moral influences

3. Science and technology

4. Civic and social institutions

5. Governmental and political processes

6. Industry and commerce

C. One basic process[1/] for harmonizing human activities with ecosystem processes involves adjusting perceived imbalances, identifying and addressing problems, and utilizing opportunities through institutions and individuals:

1. Investigating ecosystem processes and components, including results of human activities on ecosystems and the influences of ecosystems on human functioning.

2. Recognizing the importance of ecosystem processes and significance of ecosystem changes.

3. Identifying causes of ecosystem changes and their consequences.

4. Arraying alternative action strategies that would maintain and enhance beneficial ecosystem changes and would stop or reduce detrimental changes, with special attention to irreversible/ irretrievable changes, and to long-range vs. short-range commitments of resources.

1/ In the U.S., successful use of this process requires ample input from and participation of the public at all nine steps.

5. Analyzing and evaluating alternatives within a broad array of environmental, social, and economic criteria, recognizing that criteria and values will differ according to the circumstances of politics, geographic location, scale, time, and society (war, good times, flood, famine, etc.).

6. Selecting among alternatives and adopting a policy. (This occurs at individual through global levels, consciously and unconsciously.).

7. Choosing and implementing actions to carry out policy.

8. Monitoring and evaluating effects of implemented policies and actions.

9. Feeding information from step #8 back through step #1, etc., to keep actions adjusted to changing data bases, requirements, conditions, and perceptions.

D. Increasing scientific knowledge of ecosystem processes in the United States and the world, coupled with increasing citizen awareness of ecosystem disfunctions and acute environmental problems, led to establishment of policies and enactment of environmental legislation in the 1960's, which were augmented and adjusted in the 1970's.

1. The U.S. National Environmental Policy Act of 1969 incorporates a number of the fundamentals of environment into its Title 1, as part of the policy, building natural principles into U.S. law. Incorporation of these principles into U.S. law places a special mandate on human actions today and in the future. Title 1 of NEPA reads as follows: (Emphasis is added to indicate portions that state fundamentals presented in Sections I and II of this paper.)

"101a. The Congress, recognizing the profound impact of man's activity on the interrelations of all components of the natural environment, particularly the profound influences of population growth, high-density urbanization, industrial expansion, resource exploitation, and new and expanding technological advances and recognizing further the critical importance of restoring and maintaining environmental quality to the overall welfare and development of man, declares that it is the continuing policy

of the Federal Government in cooperation with State and local governments, and other concerned public and private organizations, to use all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans.

"101b. In order to carry out the policy set forth in this Act, it is continuing responsibility of the Federal Government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may --

(1) Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;

(2) Assure for all Americans safe, healthful, productive, and esthetically and culturally pleasing surroundings;

(3) Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences;

(4) Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity and variety of individual choice;

(5) Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities, and

(6) Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources."

2. Other U.S. laws address specific needs for harmonizing various results of human activities with ecosystem processes, e.g.,

   a. Environmental Education Act of 1970

   b. Refuse Act of 1899

   c. Clean Air Act of 1966 and Amendments of 1970, 1974, 1976

   d. Water Quality Act of 1966 and Amendments of 1972

   e. Federal Insecticide, Fungicide and Rodenticide Act of 1971, and Federal Environmental Pesticide Control Act of 1972

   f. Coastal Zone Management Act of 1972

   g. Marine Mammal Protection Act of 1972

   h. Endangered Species Preservation Act of 1973

   i. Marine Protection, Research and Sanctuaries Act of 1972

   j. Solid Waste Disposal Act of 1965, and Resource Recovery Act of 1970, Solid Waste Amendments of 1976

   k. Noise Control Act of 1972

   l. Non-Nuclear Energy Research and Development Act of 1974

   m. Forest and Rangeland Renewable Resources Planning Act of 1974, and Amendments of 1976

   n. Toxic Substances Control Act of 1976

   o. Whale Conservation and Protection Act of 1976

3. International environmental policy is exemplified in:

   a. Resolutions of the 1972 Stockholm Conference on the Human Environment

   b. Work of the United Nations Environment Programme

c. Convention on Oil Spills, Trade in Endangered Species, World Heritage Trust, Ocean Dumping

d. Revision in Law of the Sea Convention (in progress)

e. Resolutions of the 1975 Kyoto Conference on the Human Environment

f. Resolutions of U. N. Conferences:

(1) Population, Bucharest, 1974

(2) Food, Rome, 1974

(3) Women's Rights, Mexico City, 1975

(4) Human Settlements, Vancouver, 1976

g. Results from future U. N. Conferences:

(1) Water, Mardel Plata, Argentina, April 1977

(2) Environmental Education, Tesila, Russia, October 1977

(3) Desertification, (not set) 1977

h. Recommendations of U. N. Agency Workshops

(1) Environmental Education, Belgrade, 1975

(2) Mediterranean Pollution, Barcelona, 1976

i. Bilateral and multilateral environmental agreements, such as US-USSR Bilateral Environmental Agreement of 1972

SECTION IV. USING FUNDAMENTALS OF THE ENVIRONMENT GIVEN IN SECTIONS I AND II, AND UNDERSTANDING OF THE METHODS OUTLINED IN SECTION III

Some of the questions that must be addressed, and some of the issues that must be resolved are:

A. Questions:

1. What are the minimum per capita requirements for a quality human experience throughout life?

2. What energy resources are needed to meet these minimum per capita requirements throughout a human life span?

3. What is the food production capacity of Earth with known technologies?

4. What natural and man-made material resources are needed to meet these minimum per capita requirements throughout a human life span?

B. Issues:

1. Land suitability planning

2. Strip mine land reclamation

3. Protection of ecosystem processes affecting food production

CONCLUSION

Costs of insults to organismic systems and to ecosystems are paid by all in reduced health, as well as lowered organic and work productivity. The most equitable way to pay these costs must be worked out by the time honored democratic processes. A sound economy and a clean, healthy environment became reciprocally reinforcing by application of human ingenuity and restraint.